Progress on Cherenkov Reconstruction In MICE

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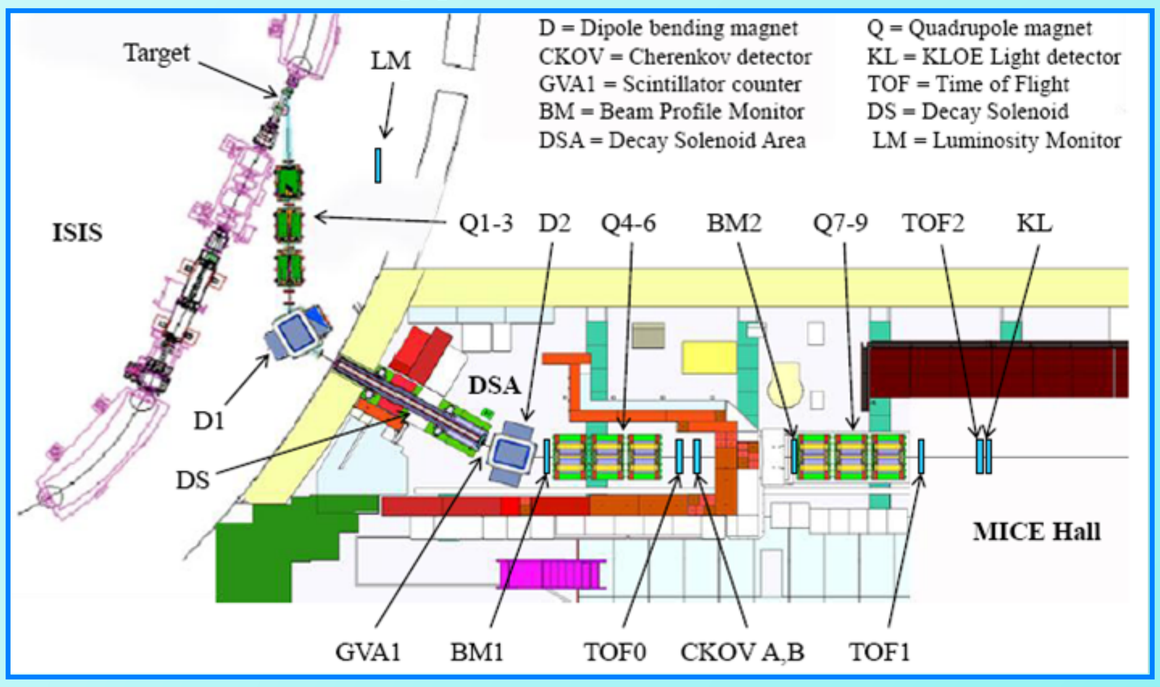
- **The MICE Beamline was designed to provide a >99% pure muon beam**
  - **Approach: momentum-select ≈ 400 MeV/c pions, then momentum-select ≈ 200 MeV/c (backwards) decay muons**
- **The actual pion contamination has yet to be determined**
  - ➢ **Hard to measure, since so small**
  - ➢ **Analysis [1] using time-of-flight counters and KL calorimeter has set ≈ 1% upper limit**
- **We show how the MICE Cherenkov (Ckov) detectors can be used to search for pion contamination in the MICE beam**

- **<u>Concept</u>:** MICE Step I [2] had time-of-flight counters, Ckovs, and calorimeters, but no magnetic spectrometers,

  ⇒ particle *velocity* known, but not momentum

  - ➢ Makes event-by-event Ckov particle ID challenging
    - So look for event *distribution* consistent with pions

- **MICE Beamline** [3]:



MICE beam ≈ well approximated in G4beamline:

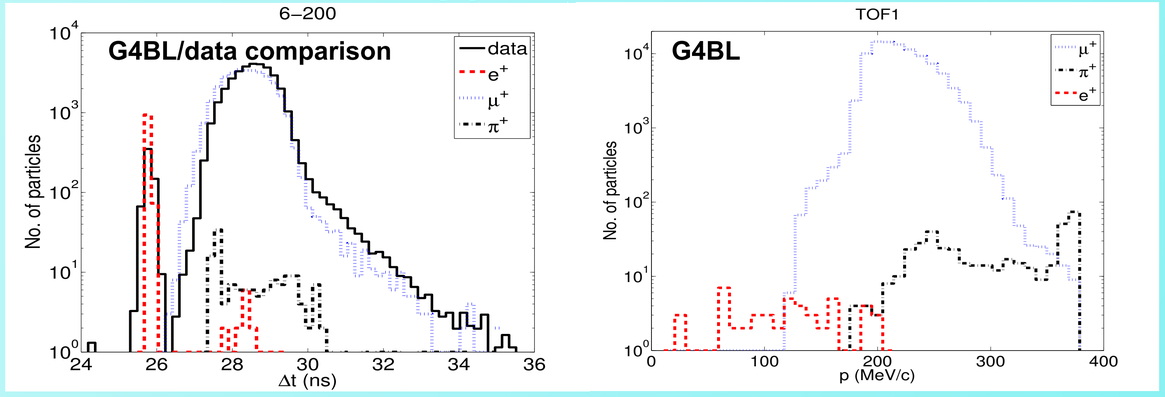


Figure: G4beamline/data comparison vs time of flight from ToF0 to ToF1 and G4beamline *p* distributions [1]

- **So G4beamline predicts a broad momentum spectrum of pions, as well as a ≈ 400 MeV/c pion spike, "sneaking through" D2, and its decay muons**

- **"400 MeV/c spike" π and μ should count in CkovA, while 200 MeV/c muons should not:**

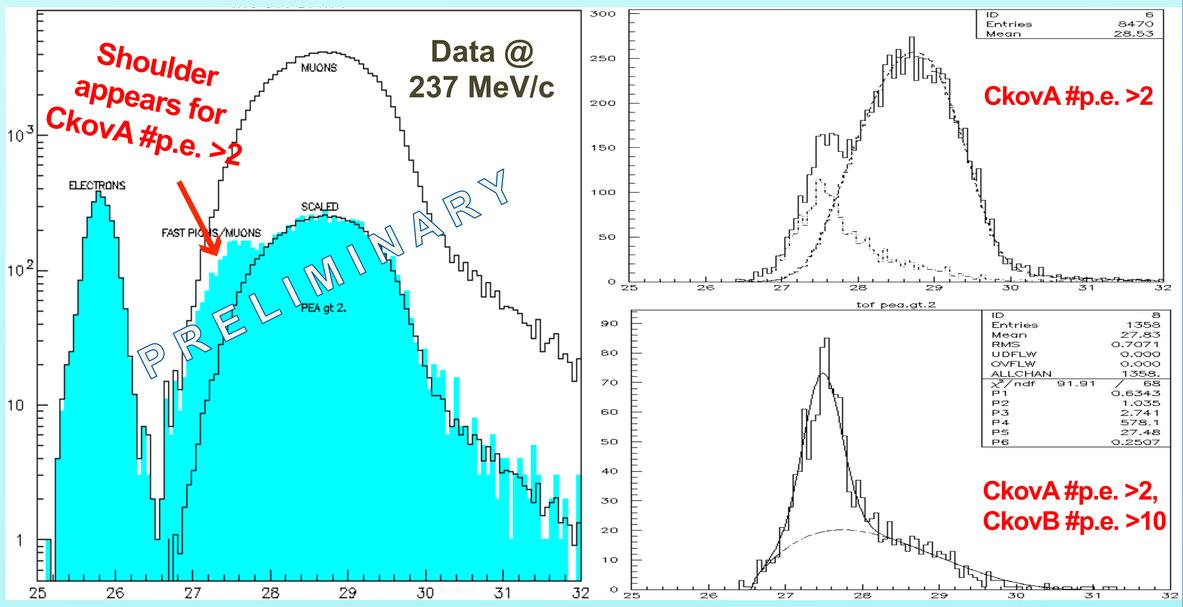


Figure: Histograms of Step I data (left) with and without CkovA cut and (right-top) with > 2 p.e. detected in CkovA and (right-bottom) additional > 10 p.e. cut in CkovB

- Peak at ≈ 27.5 ns: 539 ± 34 events
  - ➢ Consistent with ≈ 400 MeV/c MC "spike" π and their decay μ!

- **Efficiency correction:**

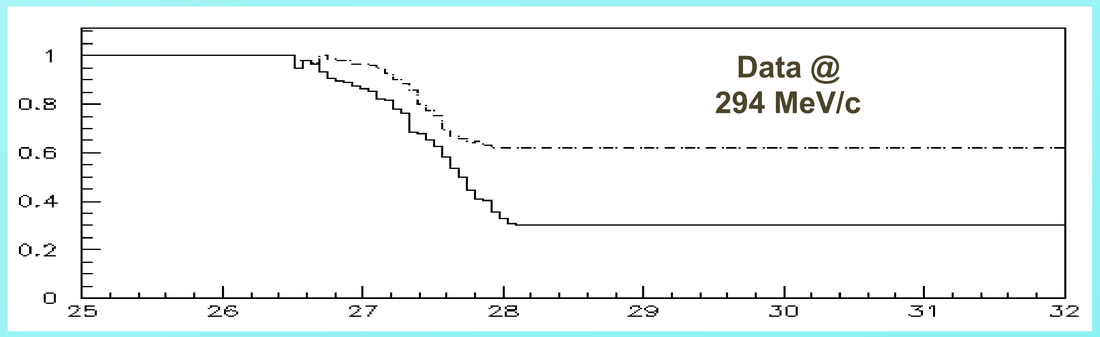


Figure: Efficiency curves vs ToF (in ns) for (top) CkovA and (bottom) CkovB

- ➢ Eff. = 53.8% (averaged over event ToF distribution)

- **<u>Limit calculation for pion fraction *R*:</u>**
- If all fast particles were π,

  R = 539 / 0.538 / 118,793 = (0.84 ± 0.05 ± 0.09)%,

  or < 0.97% @ 90% CL
  - ➢ Similar to ToF/KL analysis result
- If (G4BL) 1/20 of fast particles at ToF1 are π,

  R = 0.04% (indeed small)

REFERENCES

1. M.Bogomilov et al., "Measurement of the pion contamination in the MICE beam," MICE Note 416, June 25, 2013, http://mice.iit.edu/micenotes/public/pdf/MICE0416/MICE0416.pdf
2. D. Adams et al.," Characterisation of the muon beams for the Muon Ionisation Cooling Experiment," Eur. Phys. J. C (2013) 73:2582
3. M.Bogomilov et al., "The MICE Muon Beam on ISIS and the beam-line instrumentation of the Muon Ionization Cooling Experiment," JINST 7 (2012) P05009